Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Commission Seeks Reply Comments On Spectrum Policy Task Force Report	)	ET Docket No. 02-135
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REPLY COMMENTS OF V-COMM, L.L.C.

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V-COMM, L.L.C. (V-COMM)[1] submits these reply comments in response to the Federal Communications Commission's (FCC or Commission) Public Notice[2] seeking public reply comment on the Spectrum Policy Task Force Report (Report).[3]

It is V-COMM's intent to address the technical issues associated with the Task Force's spectrum-sharing proposals, which have the potential for causing harmful interference to Commercial Mobile Radio Service (CMRS) providers and its customers. V-COMM is active in evaluating and performing extensive interference tests with spectrum sharing technologies and

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[1] V-COMM, L.L.C. is a wireless telecommunications consulting company with principal memebers having over 20 years experience in the wireless industry. We have provided our expertise to wireless operators in RF engineering, system design, implementation, performance, optimization, and evaluation of new wireless technologies. We have extensive industry experience in all CMRS technologies. V-COMM's company information and experiences are highlighted in the report's Appendix, along with biographies of senior members of its engineering team.

[2] Commission seeks reply comments on Spectrum Policy Task Force Report, ET Docket No. 02-135, Public Notice released Nov. 25, 2002, and extension of response dates within Public Notice released Dec. 11, 2002.

[3] *Spectrum Policy Task Force Report,* ET Docket No. 02-135, released Nov. 25, 2002. (Report).

CMRS networks.[4] Serving as an independent wireless engineering firm, V-COMM has conducted numerous interference tests within CMRS networks with actual market environment conditions, and has documented these results for consideration of the Commission. Through extensive testing, V-COMM has gained specific knowledge of the compatibility issues associated with spectrum-sharing technology and has observed the effects of harmful interference caused by the use of this technology.

V-COMM has reviewed the Spectrum Policy Task Force Report, provided engineering analyses, and prepared this report pursuant to a contract with a consortium of cellular companies composed of AT&T Wireless, Cingular Wireless, and Verizon Wireless.

I. INTRODUCTION AND SUMMARY

V-COMM has reviewed the Report and the comments submitted within this proceeding, in relation to the Task Force's stated mission,[5] which is reproduced below:

- Provide specific recommendations to the Commission for ways in which to evolve the current "command and control" approach to spectrum policy into a more integrated, market-oriented approach that provides greater regulatory certainty, while minimizing regulatory intervention; and
- Assist the Commission in addressing ubiquitous spectrum issues, including interference protection, spectral efficiency, effective public safety communications, and international spectrum policies,

And, it is reviewed in relation to Chairman Powell's directive to the Task Force to identify and evaluate changes in spectrum policy that will increase the public benefits derived

[4] In a cooperative effort with interested parties, V-COMM has conducted extensive compatibility and interference tests within the AT&T Wireless, Cingular, and Verizon Wireless networks, as part of the AirCell spectrum-sharing proceeding. AirCell technology currently operates under a FCC waiver that allows co-existing within the Cellular spectrum.

[5] Report, pg. 1.

from the use of radio spectrum, and regarding comments in Chairman Powell's press statements:[6]

> "Today's customers demand access to interference-free spectrum. When we turn on our cell phone we expect it to work"
>
> "Spectrum-based technology developers … have increasingly developed technologies that make signals more vigorous", and "They have largely developed sensory and adaptive technologies that allow transmitters and receivers to interact dynamically with the environment and to "find" open spectrum for use only when they need it."
>
> "The public has made their desire for interference-free spectrum-based services quite clear. The challenge now rests with us [FCC] to deliver."

V-COMM supports the stated objectives of the Task Force and the Chairman in this proceeding reference to improving and increasing the use of spectrum. However, the Report does not provide adequate guidance on ways to evolve to the new spectrum policy approach. Its "interference temperature" concept has many technical flaws associated with its use, and its proposals to rely on undeveloped RF and intelligent technologies will not sufficiently protect existing licensed Commercial Mobile Radio Service (CMRS) providers, and their customers, from the effects of harmful interference. The concept of introducing additional unlicensed communications services within spectrum bands that currently operate spectrally efficient commercially licensed services is not well supported, and has the possibility of increasing the interference noise floors and causing harmful interference to these existing commercial services. In this respect, the Commission and Task Force should carefully consider the preservation of existing services as a first priority.

Secondary market arrangements are the exception to these issues. With this approach, the spectrum-sharing interference issues become the responsibility of the licensed operator. In

[6] Press Statement of Chairman Michael K. Powell on Spectrum Policy Task Force, released Nov. 7, 2002.

this application the licensed operator maintains control over the new service and manages the integration of the new systems, along with addressing the compatibility and proper interference controls between both systems. The secondary market application is one of the few applications that holds promise in meeting the FCC Chairman's goal of increasing use of spectrum and the Task Force mission of attaining "greater regulatory certainty, while minimizing regulatory intervention." Other spectrum-sharing alternatives will require substantially more intervention from the Commission to address, outline, enforce, and resolve ongoing interference issues with existing and future equipment. These tasks can be quite extensive and should not be under estimated.

V-COMM strongly agrees with the Task Force's recommendation that these "models must be based on clear definitions of right and responsibilities of both licensed and unlicensed spectrum users, particularly with respect to interference and interference protection."[7] Along with this statement, it is important that the FCC's definition of harmful interference is updated to reflect current engineering practices and modern communication services. Sufficient protection against the effects of harmful interference for CMRS voice, data and location services need to be updated for system attributes including coverage, capacity and quality of service. These definitions should be clearly specified within FCC Rules, with metrics and procedures that are well accepted in the industry and objectively quantified.

V-COMM agrees with statements in the Interference Avoidance[8] section of the Report regarding interference management becoming more difficult with greater density, mobility and variability of radio frequency emitters, and that it becomes more problematic when licensed

[7] Report, Pg. 3.

[8] Report, Pg. 4.

spectrum users are granted increased flexibility. In addition, we believe that the Commission should undertake a systematic study of the RF noise floor to better understand the existing radio environment. It is essential for the Commission to understand the radio environment before considering rule changes and adopting interference measurement procedures and tolerance levels. As outlined in the Spectrum Noise Floor Studies section of this report, V-COMM has conducted comprehensive spectrum noise floor studies in CMRS spectrum bands and is planning additional noise floor studies for the consideration of the Commission.

However, V-COMM has significant reservations regarding the Task Force's "interference temperature" limit and time sharing models, due to increased noise floors and harmful interference to incumbent licensed spectrum users. Many technical flaws regarding these spectrum-sharing models are addressed in this report. These include ever-increasing noise floor conditions, sensory devices and smart radios that are not capable of exploiting the use of spectrum holes without causing harmful interference, and models that discourage licensed service providers from developing and deploying advanced technologies that reduce self-interference and more efficiently utilize spectrum.

Regarding the Task Force's proposed spectrum models,[9] V-COMM agrees with the Task Force and other comments in this proceeding including TIA's comments, which state that "bands below 5 GHz are better suited for exclusive use licensing than for a commons approach", and "Access to others in this exclusive use spectrum can be through secondary markets. Forced access would limit innovation and harm the ability of incumbents to implement new technologies." In particular, CMRS spectrum should be assigned to the exclusive use model due to the density, mobility, and increased importance and reliance placed upon its use. CMRS

[9] Report, Pg. 5.

spectrum is used by approximately 140 million subscribers through a network of approximately 140 thousand base stations. This spectrum supports a growing percentage of landline displaced calls, approximately 35% of 911 emergency calls, and serves as priority access communication systems to government agencies in critical times of homeland security.[10] Interference-free operations for these users are critical. The Commission should not jeopardize or degrade these existing licensed services. The commons use model should be restricted to allocated bands of spectrum with similar unlicensed services and compatible operational characteristics.

II. INTERFERENCE AVOIDANCE CONCEPT FLAWS

The Task Force recommends that the Commission adopt a quantitative standard, the "interference temperature" concept, to determine harmful interference and to establish a maximum interference limit that would allow new spectrum-sharing users to co-exist within previously occupied bands of spectrum. V-COMM agrees with the Task Force in regards to establishing quantitative standards, metrics, and specification of proper measurement procedures to measure, quantify, and determine harmful interference.

However, V-COMM has significant reservations regarding the Task Force's "interference temperature" concepts, due to increased noise floors and harmful interference to CMRS spectrum users. These concepts include operations using real-time adaptation based on the actual RF environment, spectrum-sharing devices using sensory mechanisms & intelligence to determine the occupancy of spectrum and determination of interference to a "victim" receiver

[10] T-Mobile currently offers wireless priority access service in New York; Washington, D.C.; Atlanta; Richmond, Va.; and 11 other cities. Cingular is coordinating similar arrangements in the Carolinas with top government officials and rescue workers by the end 2003. These deployments are designed to give authorized personnel the best opportunity to have their cell phone calls go through in emergency situations.

system.   These new time-sharing and "interference temperature" concepts have many technical flaws, unresolved issues, and practical instances that will cause harmful interference to existing CMRS spectrum users. These conceptual flaws in the "interference temperature" model are explained in the following sections.

A. Spectrum Time-Sharing Concepts And Sensory Devices Will Cause Harmful Interference To Incumbents

The proposed "interference temperature" concept is technically flawed, overly simplistic, and will not protect CMRS spectrum users from harmful interference. From a laypersons standpoint the concept may appear reasonable, however in practical engineering terms and real-world circumstances, the concept will cause problems for licensed spectrum users. The system would result in many "false positives" for spectrum sharing devices that use sensory mechanisms and intelligence, in an attempt to time-share licensed spectrum use and prevent harmful interference to "victim" receiver systems. These examples include the following:

1. As many others have commented in this proceeding, any signal path obstructions or signal penetration issues would easily result in a false indication of spectrum availability. This scenario is depicted in the diagram below (Figure 1).   In this case, the sensory devices will not be able to detect the transmission from the CMRS base station, due to the signal path blockage and penetration through structures in the local environment. In this case, the forward (cell to phone) spectrum channel would *appear* unused, as measured by its scanning receiver, however it is actually in-use by a nearby licensed spectrum user. When the spectrum-sharing device transmits, its signal can be received by the primary spectrum user's mobile station and cause harmful interference.

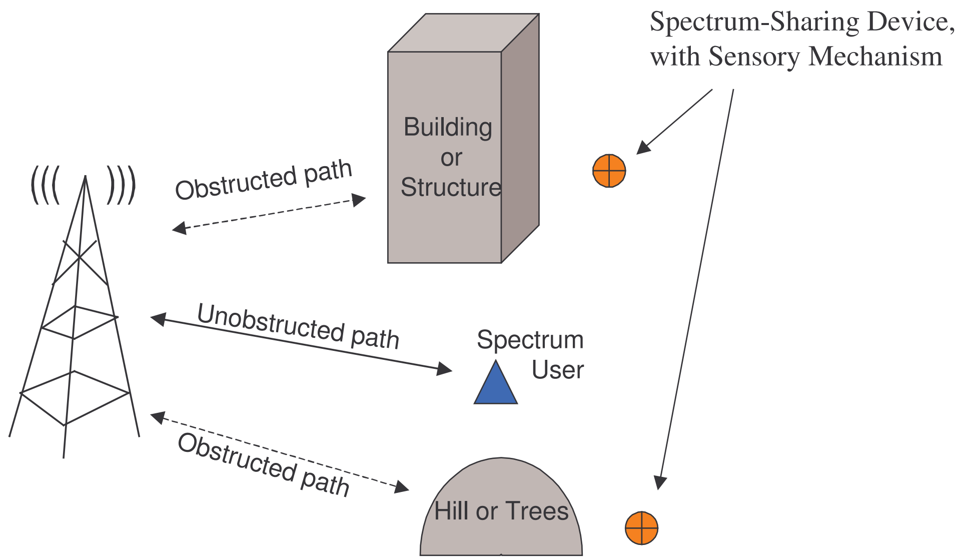

Figure 1 Obstructed signal paths to sensory devices cause incorrect assessment of spectrum availability

2. Another situation that would result in interference, would be a spectrum-sharing device that is out-of-range of the base station signal, as depicted in Figure 2 (below). Due to the range of the signal path from the base station to the spectrum-sharing device, the device would not receive sufficient signal strength and would interpret this as a false opportunity for spectrum sharing. In this case, the spectrum would *appear* unused, as measured by the scanning receiver, however it is actually in-use by a nearby licensed spectrum user. When the spectrum-sharing device transmits, its signal will be received by the primary spectrum user and cause harmful interference.

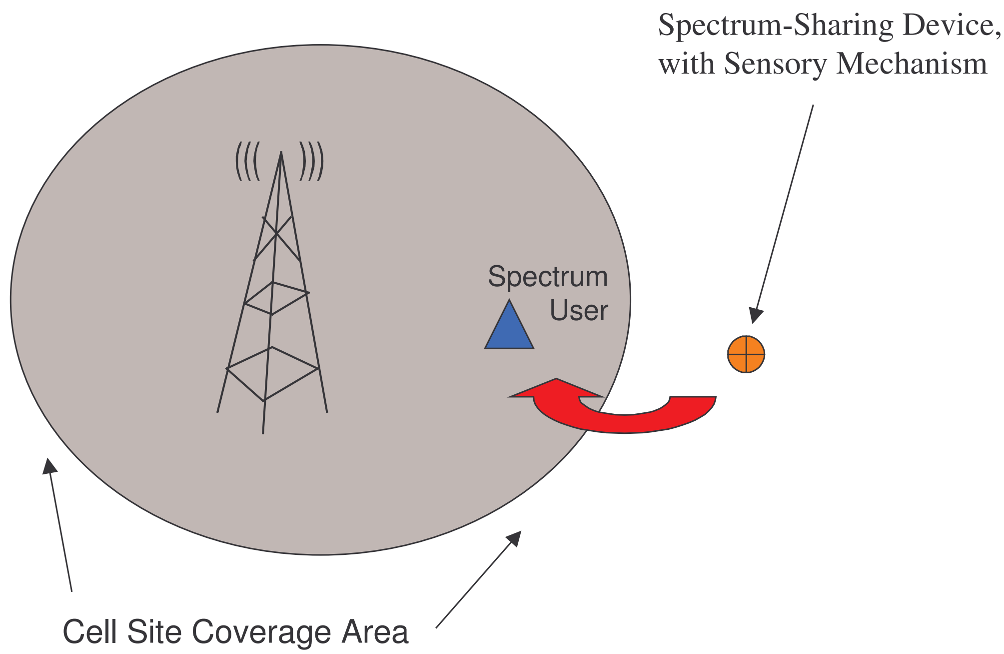

Figure 2 Sensory device out of range of base station coverage area causes incorrect assessment of spectrum availability, upon transmitting, causes interference to mobile station within range

3. Another issue is reverse-link (phone to cell) vs. forward-link (cell to phone) measurements. A spectrum-sharing device that is measuring the reverse-link spectrum may not be able to detect nearby mobile signals, and assume the spectrum is unused. Upon transmitting on this link its transmission could be received by nearby base stations, increase their noise floors, and cause harmful interference.

4. In addition to the three examples described above, there are numerous other examples that would result in similar "false positive" indications of spectrum availability, due to other differences in the spectrum-sharing device and primary spectrum user's system.

    a. Location - the spectrum-sharing device may be located within buildings, urban canyons, coverage holes and other locations that cannot detect spectrum use, but can cause interference to nearby licensed spectrum users.

    b. Antenna - the spectrum-sharing device may have different antenna types, gains, orientations, polarization and location than the primary spectrum user. This results in a different signal level and noise floor level for the device, as compared to that experienced by the "victim" spectrum user's antenna.

c. Receiver - the spectrum-sharing device may have different receiver characteristics, including resolution bandwidth, detector circuits, noise figure, sensitivity and technology than the licensed spectrum user. These would all contribute to a different signal and noise measurement at the spectrum-sharing sensory device, as compared to the "victim" spectrum user's receiver.

5. Another situation that would result in interference, is when the spectrum-sharing device detects an opportunity to use spectrum that is available, and while transmitting it is unable to detect that the primary spectrum user also has begun transmitting. Many devices would not be able to transmit and receive on the same frequency at the same time. Even devices that employ time division duplex (TDD) operation do not transmit and receive simultaneously. Even in this circumstance, failed system access attempts may occur, in addition to pieces of voice conversations being lost.

In the Report, regarding the Task Force's time-sharing proposals, it characterizes an "interference temperature" measurement that is overly simplistic and optimistic.[11] In the Report's Figure 1, the best case scenario is depicted with a sensory device having perfect knowledge of the victim receiver's radio environment, and presumably making perfect decisions. The Report fails to address other scenarios where the radio environment and interaction between the devices are not so favorable.

B. Interference Temperature Limit Proposal Will Increase Noise Floor Conditions For Incumbents

In the Report, the Task Force proposes an "interference temperature" metric that is used to establish a maximum permitted level of interference to a licensed spectrum user, by measuring

[11] Report, Figure 1, Pg. 28.

the “worst case” interference environment at a receiver.[12] This proposal is also overly simplistic and optimistic. It represents an idealistic scenario where the sensory device has perfect knowledge of the victim receiver’s radio environment and equipment type, and can make perfect decisions. The Report fails to address other scenarios where the radio environment and interaction between the devices are not so favorable. There are many circumstances in which the use of this concept will increase spectrum noise floors and cause harmful interference to licensed CMRS providers and users. The problems with the interference temperature limit proposal are:

1. The first major problem with the interference limit proposal is that it assumes the signal and noise levels measured at the spectrum-sharing device are the same as the licensed spectrum user’s receiver. As provided in examples above (Section I-A.4), differences in location, receiver characteristics, antennas and other environmental issues will result in a spectrum-sharing device that measures a very different radio environment than the licensed spectrum user’s receiver. These differences will detract from the ability to make intelligent decisions regarding the noise levels measured at the victim receiver. Without using the actual victim’s receiver, antenna, and location, the spectrum-sharing device will not be able to measure the victim’s maximum interference level. And, for the same reasons, the spectrum-sharing devices would not be able to measure its contribution to the aggregate interference level at the victim receiver.

2. Second, in cases when the licensed signal is a weak signal, the sensory device will *not* be able to distinguish between “licensed signals” and internal system interference. In these cases, only the licensed operator knows when a nearby radio channel is in-use by its network, and can resolve whether any measured signals are from nearby “active calls” or co-channel self-interference. Without this information, interference temperature measurements are not reliable, they can misinterpret “licensed signals” for self-interference, and results in inappropriately high interference temperature limits. Once again, the Task Force is

[12] Report, Pg. 28-30, Figures 2 & 3, regarding the Task Force’s proposals for Interference Limits or “Caps”. In these figures, the Task force references the maximum interfering signals measured and the adoption of a permitted interference limit for unlicensed spectrum-sharing users at those levels.

describing an idealistic measurement system that has perfect knowledge of the radio environment, which is an unrealistic and unlikely situation.

3. Third, the sensory device will *not* be able to distinguish the licensed self-interference from non-licensed and undetermined sources of interference. In these cases, it's possible the undetermined source is from a faulty transmitter, equipment that is not in compliance with FCC emission limits, or inter-modulation products created within the sensory device. It's also possible that the undetermined source is from another spectrum-sharing user. Therefore, it would not make sense to set interference levels based upon non-licensed or undetermined interference sources.

4. Fourth, the interference temperature limit can result in an ever-increasing noise floor. In this scenario, when spectrum-sharing devices increase noise floors and incumbent licensed operator increase their signals to overcome this additional noise, the incumbent's self-interference levels is increased. This in turn increases the interference temperature limit, which allows the spectrum-sharing devices to increase their power, and the entire process continues, until one system runs out of power or both systems are defeated.

5. The next major issue is related to the Task Force's method of setting the permitted interference limit for licensed spectrum users. In figures in the Report,[13] the Task Force adopts a permitted "interference temperature" limit *at* the maximum measured interference level. This method is unreasonable and will certainly lead to significant cases of harmful interference to licensed spectrum users. V-COMM questions the merits of the Task Force's proposed method. Its proposal is to measure the "worst case" radio environment at a particular receiver, at a particular moment in time and on a particular spectrum channel, and then, make *that* level (the worst case interference level) the level of permitted interference for all other unlicensed spectrum users to occupy. In most radio systems, there are usually worst-case temporary interference conditions that exist at specific locations, however that does not imply that it exists everywhere, and all the time. These are mostly special cases, rather than normal occurrences. To apply this maximum interference level to every location within a system would lead to significant harmful interference to the licensed spectrum users. This proposal seems contrary to what is expected of the Commission, which is to strive at

[13] Report, Pg. 29, Figures 2 & 3.

improving the use of spectrum, and make attempts to improve (lower) the noise floor, which would allow increased use of spectrum. Instead of taking the worst-case environment and adopting it everywhere, it would be better to improve and extend the best-case interference (lower noise floor) environment.

6. The Task Force Report does not recognize that most times the interference noise floor is lower than the maximum level, and that licensed spectrum users *do* take advantage of the spectrum at these times, which results in improved spectrum access at lower signal levels.

7. Another problem inherent with establishing this maximum "interference temperature" concept, is that there would no longer be an incentive for licensed service operators to develop and deploy advanced technologies that reduce self-interference and more efficiently utilize spectrum. Technology advancements involve improving and lowering internal system noise floors to achieve improvements in spectrum efficiency. Consequently, by establishing this interference "cap", it could stifle advances in technology and pose significant limits on future spectrum use for incumbent licensed carriers. Examples of CMRS technologies and operations that reduce self-interference levels are provided at the end of this section (I-B).

8. Lastly, if this maximum "interference temperature" concept is adopted, any problems that are encountered down the road will most likely be uncorrectable. That is, if future unlicensed devices are permitted to proliferate by the millions and occupy spectrum in this manner, it would cause harmful interference to licensed operations, and there would be no mechanism to remove these devices from the market. Unlicensed devices by their very nature cannot be removed from the market once put into circulation. In this respect, there is zero-tolerance for mistakes.

Examples of CMRS technologies and network operations that reduce self-interference levels are outlined below. This reduction of self-interference has allowed increased service areas, particularly for in-building mobile phone users. These examples include:

- Advanced power control algorithms - With advanced power control algorithms self-interference levels are reduced. In CDMA systems, the power control algorithm adjusts the power level 800 times per second in 1 dB increments, to serve calls at the lowest power required to maintain call quality. In addition, CDMA voice activity algorithms further reduce self-interference levels (by reducing transmit power levels) when users are not speaking (representing about 55% of the time).

- Soft handoff & diversity path improvements - In CDMA systems, soft handoff and RAKE receiver systems allow base stations and phones to operate at reduced power levels (which reduces self-interference levels), due to combining of multiple signals.
- Lower mobile phone transmit power - The maximum transmit power level for mobile phones decreased from 3 watts car phones, to portable phones with 600 mW for AMPS & TDMA phones, and 200 mW for CDMA phones. Typical operating power levels for phones decreased considerably with power control algorithms based on call quality thresholds, i.e. operating power levels for CDMA phones are about 1 mW. These lower transmit power levels create lower self-interference levels at base stations.
- Lower base station transmit power – In mature CMRS systems, base stations typically utilize lower transmit power settings to maintain system performance. This reduces self-interference levels received at mobile phones.
- In-building wireless phone use - With strong market penetration and moderate cost of wireless phone service, in-building wireless phone use has increased substantially. This trend is expected to continue, and will result in lower self-interference levels at base stations and phones, due to the penetration loss of the building structure.

These trends are expected to continue into the future with third and fourth generation CMRS technology lowering self-interference levels and utilizing spectrum more efficiently. Establishing a maximum interference threshold will discourage CMRS service providers from deploying advanced technologies and improving spectrum efficiency.

C. Spectrum-Sharing Interference Is Unlike Out-of-band & Part 15 Emissions

The Task Force recommends establishing an "interference temperature" threshold above the actual noise floor of licensed spectrum users. This would increase the noise floor for incumbent providers above and beyond the current level, which consists of out-of-band emissions, Part 15 devices, man-made and environmental electrical noise, and self-internal interference. This would presumably establish an agreed-to level of interference that licensed service providers would have to accept. If approved, this new type of interference would be unlike out-of-band & Part 15 emissions,[14] since the Commission *does* have the ability to control and prevent this new type of spectrum-sharing interference. Part 15 and out-of-band emissions limits are primarily set based on radio equipment design compromises, engineering tradeoffs, technology issues, cost of equipment and other practical factors that are not easily overcome. In contrast to these practical reasons, the Task Force suggests allowing the interference noise floor to increase for very different reasons. Any benefits derived from new spectrum-sharing systems and its increased interference must be carefully weighed against the impact of such use to incumbents licensed spectrum users.

D. Internal vs. External System Interference

In its Report, The Task Force refers to "interference" and spectrum noise floor levels without distinguishing between internal system interference and external system interference. For a CMRS Service Provider and other incumbent licensees, these types of interference are vastly different. Internal system interference is under control of the service provider while external system interference cannot be controlled, managed or mitigated in any way by the provider.

As CMRS systems grow and markets mature, CMRS providers have numerous techniques and methods to continually manage their internal system interference levels. The CMRS service providers' radio frequency (RF) engineering coordinators and performance

[14] These include Part 15 unlicensed emissions (unintentional and intentional).

monitoring staff employ these techniques on a regular basis to maintain and mitigate internal system interference.[15] These techniques include:

- Designated frequency assignment per base station coverage area, where the RF engineer consistently maintains and re-tunes its network to optimize performance and mitigate internal interference.
- Down-tilting antennas, lowering antenna heights, deploying narrower horizontal beam-width antennas, and other adjustments to reduce the reception of internal system interference.
- Reducing base station and mobile transmit power levels, and utilizing diversity receive antenna systems reduce the surrounding internal interference levels to allows base stations and mobiles to complete calls at lower received signal levels.
- CMRS system settings can minimize the effects of internal interference through the use of handoff and access protocols that keep the mobile phone communicating with the closest base station, thus minimizing the internal interference each caller observes.
- Underlay / Overlay (dual) cell configurations,[16] which allows closer frequency reuse for frequencies used within the inner rings. This technique allows service providers to maintain calls requiring lower noise floors on outer ring coverage areas.
- Advanced frequency assignment techniques using flexible (dynamic) frequency assignments,[17] where the system knows which channels are used at nearby base stations, and avoids those channels that are active in those nearby base stations.[18]

External system interference is quite different. Licensed service providers and its customers do not have any control or ability to manage or mitigate this type of interference. The source of the external system interference is extremely difficult to detect and monitor ongoing.

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[15] Internal system interference primarily consists of the co-channel and adjacent channel interference received from neighboring base stations and mobile phones.

[16] Dual-cell configurations are utilized in some AMPS, TDMA and GSM wireless systems.

[17] Flexible frequency assignment techniques are utilized in some TDMA and GSM wireless systems.

[18] This flexible frequency assignment is not performed with scanning and sensing equipment, rather it knows which channels are in use from internal system information provided by the CMRS switch.

In contrast, CMRS service providers have the ability to detect and control internal interference with frequency planning tools and system performance tools. The licensed operator knows the co-channels and adjacent channels used within its own network, and it can make adjustments accordingly. External system interference will be controlled by the external system, which manages its power control and other parameters to benefit its own coverage and performance requirements.

In the Report, the Task Force states that "[d]igital signals are inherently more robust, and resistant to interference, than analog signals… coding and error correction, are more effective at rejecting interfering signals."[19] It should be noted that this statement is misleading and not true for CMRS systems. It's true that digital signals are inherently more robust than analog signals, given that other system attributes are equivalent. In the CMRS industry, the primary reason for deploying digital system technology is to increase network capacity. With multiple voice conversations digitally "stacked" onto the same channels as before, the digital signals are *less* robust than analog. Within the CMRS industry, an example of this is the deployment of digital technology (TDMA 30 kHz), which is an upgrade of the analog (AMPS 30 kHz) technology. In upgrading from AMPS to TDMA, some service operators noticed a slight increase in the required carrier-to-interference ratio for acceptable quality service, i.e. from 17 dB to 18 dB. With digital signals sharing the same channel, all of the "robustness" of the digital technology was used to provide additional capacity and none was reserved for additional interference protection. Further evidence of this is verified in V-COMM's controlled interference tests

[19] Report, Pg. 13.

conducted at an AMPS and TDMA base station.[20] It was noted that TDMA digital technology exhibited blocked and dropped calls at an injected interference level that was 6 dB lower than AMPS analog technology. The results of these tests show that analog technology was more robust than digital.

CDMA digital spread spectrum technology is similar. In CDMA (IS95) systems, approximately 15 to 20 users are sharing the same radio channel, and the same channels are used in every cell site. The robustness of the CDMA technology was optimized to increase capacity for CMRS systems, and not for additional rejection against external system interference. In CDMA systems, the system is power controlled 800 times a second to within 1 dB of the lowest power that is capable of providing service.[21] With this tight system power control, the internal noise of the CDMA system is kept to an extremely low level, with signals operating very close to the thermal noise floor.[22] With these very low signal levels, CDMA systems are particularly sensitive to external system interference. Even when external interference is received at or below the noise floor of a CDMA system it will be received at similar or stronger signal levels than the CDMA traffic signals, and will cause harmful interference.

In addition, CDMA systems have internal controls to manage its internal interference, and have signal characteristics designed to allow the system to mitigate the effects of the non-

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[20] V-COMM conducted base station interference tests at a TDMA and AMPS base station, in conjunction with an AirCell compatibility test program. These test results will be submitted to the FCC during the public comment period for the FCC proceeding regarding the extension of the AirCell waiver.

[21] CDMA systems adjust power levels in 1 dB increments at a rate of 800 times per second, to maintain calls at the lowest operating power levels that provide acceptable voice quality.

[22] CDMA signals operate as low as the base station receive sensitivity level, i.e. -124 dBm, with noise floor levels at -109 dBm (kTB=-113 dBm, Noise Figure =4 dB, EbNo=6 dB, Processing Gain=21 dB). CDMA signals have the ability to operate at, and below the thermal noise floor of its receivers due to the inherent processing gain of the system. This processing gain is used to provide capacity for the system, and not as an interference margin for external systems, as deployed in military applications. In Cellular and PCS CDMA systems, there is no margin reserved for external system interference.

desired users signals over the desired user signal. In this way, it optimizes the use of its spectrum and the internal interference to provide coverage and capacity to its subscribers. Any external interference would increase the noise floor of a CDMA system and cause decreased coverage, capacity and/or service quality.

Future technologies also hold promise for mitigating self-interference levels, as provided in Cingular's statements below:[23]

> "Technologies such as joint detection, multi-user detection, and interference cancellation can effectively remove self interference because the statistical characteristics of the signal are well known to the receiving systems in the network (mobile and base). With these advanced technologies, the system will limited only by the noise and external system interference which cannot be removed. If unlicensed operations were allowed at power levels based on the total interference level (including the self-interference), there would not be an incentive to deploy the advanced receiver technologies. For cellular systems, the self-interference should never be used as a guide to set the interference threshold, or temperature, for the spectrum band being used."

Regarding the impact of external noise on CDMA systems, Lucent has investigated this effect on reverse-link system coverage and quality, in a document submitted in this proceeding.[24] In Appendix A of its comments, Lucent quantifies the effects to CDMA coverage and capacity based upon a static interferer. V-COMM agrees with Lucent's analysis and recommends the Commission consider these harmful effects to CDMA systems. In addition, harmful effects to CDMA quality of service (Blocked & Dropped Calls, Poor Voice Quality) can be expected with dynamic or transient sources of external interference. V-COMM agrees with Lucent's conclusion that "external interference will negatively impact the capacity and coverage of

[23] Cingular's comments submitted Jan. 27, 2003, Pg. 21.

[24] Lucent Technologies' comments are submitted in the ET Docket No. 02-135 proceeding, on Jan. 27, 2003.

CDMA systems."[25] In Lucent's quantitative analysis, an external interference power equal to the noise level of a CDMA receiver (assumed -109 dBm for base stations) will decrease system coverage by 30%, or decrease system capacity by 82%.[26] And, an external interference power at -115 dBm, or 6 dB below a CDMA receiver's noise level, will decrease system coverage by 10%, or decrease system capacity by 20%.[27] Also, an external interference power of -120 dBm, or 11 dB below a CDMA receiver's noise level, will decrease system coverage by 4%, or decrease system capacity by 6%.[28] These levels of external interference represent harmful interference to CDMA networks.

In summary, internal system interference is quite different than external system interference. The external system interference is not under control of the primary licensee's system, and any increase in the noise floor observed by the licensed spectrum user will result in a loss of coverage, capacity, and/or quality of service.

For these reasons the Commission should not permit additional external interference with levels equal to or lower than internal interference level. Using the internal interference level as the "interference temperature" limit would lead to an increase in the spectrum noise floor, cause a deterioration in CMRS service and discourage service providers from deploying more spectrally efficient technologies in the future.[29]

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[25] Lucent Technologies' comments submitted Jan. 27, 2003, Annex A, Section 4. Summary.

[26] Lucent Technologies' comments submitted Jan. 27, 2003, Interference Avoidance Section.

[27] Lucent Technologies' comments submitted Jan. 27, 2003, Introduction and Effect on Reverse Link Capacity Sections.

[28] Lucent Technologies' comments submitted Jan. 27, 2003, Effect on Reverse Link Coverage and Capacity Sections.

[29] Most improvements in spectrum efficiency involve lowering internal system operating noise levels and utilizing signals closer to the noise floor. Establishing a fixed noise level would prevent service providers from the ability to improve their use of the spectrum in the future.

E. SDR, Smart Radios: Undeveloped, Unproven Technology For Interference Avoidance Applications

In response to the Task Force's proposal to utilize Software Defined Radio (SDR) technology as an enabling technology to share-spectrum, V-COMM would like to echo statements made by CTIA, Qualcomm and Arraycomm submitted in this proceeding. These include statements from CTIA regarding "[these] technologies are still currently in the development stages, and at present time have not proven either technically or economically viable…should not be positioned as a spectrum management panacea."[30] Also from Qualcomm, "it is unlikely that SDRs [interference avoidance feature]… will be implemented in commercial equipment", and "it is impossible with today's technology for the radio to sense the impact that its operations will have on the operations of another radio. The radio cannot 'hear' another receiver."[31] Also from Arraycomm, "Such a technology would require major technology advances in RF components to be feasible at all, and additional manufacturing and technology advances to be feasible at consumer price points and form factors."[32]

V-COMM would like to reiterate these points and state that today's consumer radio devices contain significant software components, however these developments do not offer any increased protection against harmful interference as the Task Force implies. Furthermore, it would not be sound spectrum policy to rely on undeveloped, unproven technology to meet the goals of increasing the use of licensed spectrum.

[30] CTIA submitted comments, Jan. 27, 2003, Pg. 12.

[31] Qualcomm submitted comments, Jan. 27, 2003, Pg. 3-4.

[32] Arraycomm submitted comments, Jan. 27, 2003, Pg. 11.

F. Reply Comments To Motorola, Lucent & Shared Spectrum Company Statements

Reply Comments To Motorola's Statements

The Task Force's Report contains the following two Figures that describe signal and noise levels as functions of distance from the licensed transmitter.

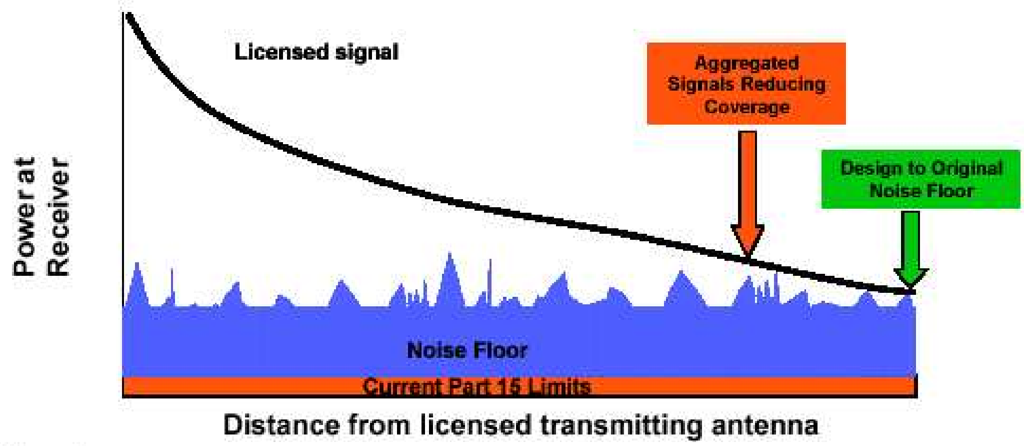

Figure 2

Figure 3 Reproduction of the Task Force's Report Figure 2

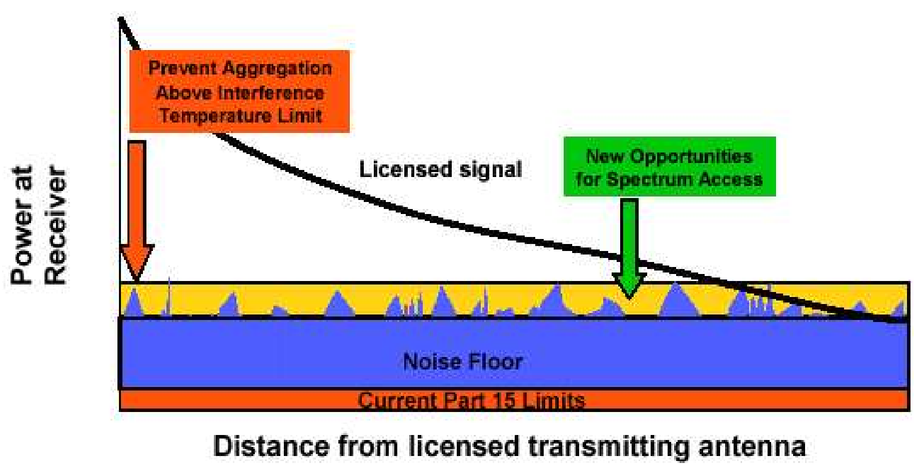

Figure 3

Figure 4 Reproduction of the Task Force's Report Figure 3

Motorola discussed these two Figures (above) in its comments submitted in this proceeding. In their comments, Motorola suggested that a fixed "interference temperature" cap should not be used, but that the cap should be based on retaining a minimum C/I at the victim receiver. This is shown in Motorola's Figure 1 (Figure 5, below). Motorola also noted that for some types of modulations, the interference power alone does not provide enough information to adequately determine the effect on the victim receiver. In some cases, additional details such as the modulation of the interfering signal must be considered.

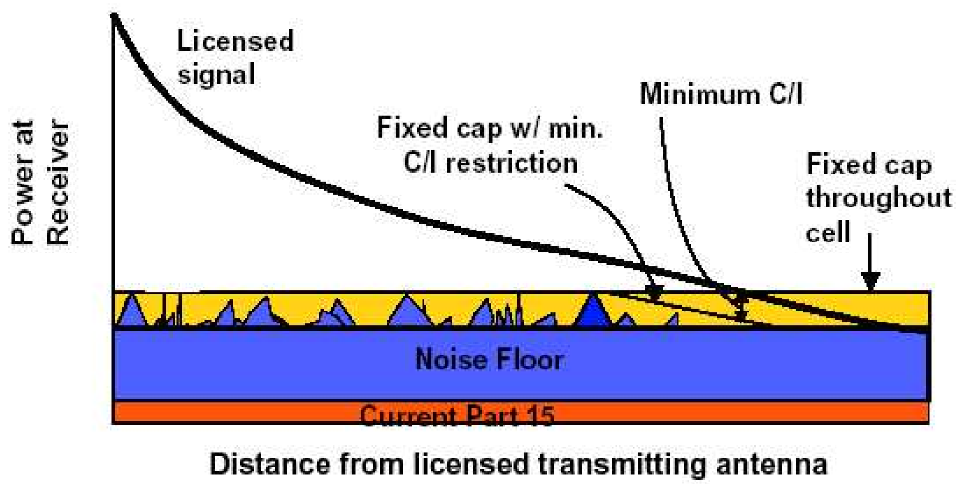

Figure 1

Figure 5 Reproduction of Motorola Report Figure 1

Motorola continues by explaining that the model described in their Figure 1 (Figure 5, above), also does not take into account sources of interference that are in close proximity to the victim receiver. The effect of nearby interferers is shown in their Figure 2 (Figure 6, below).

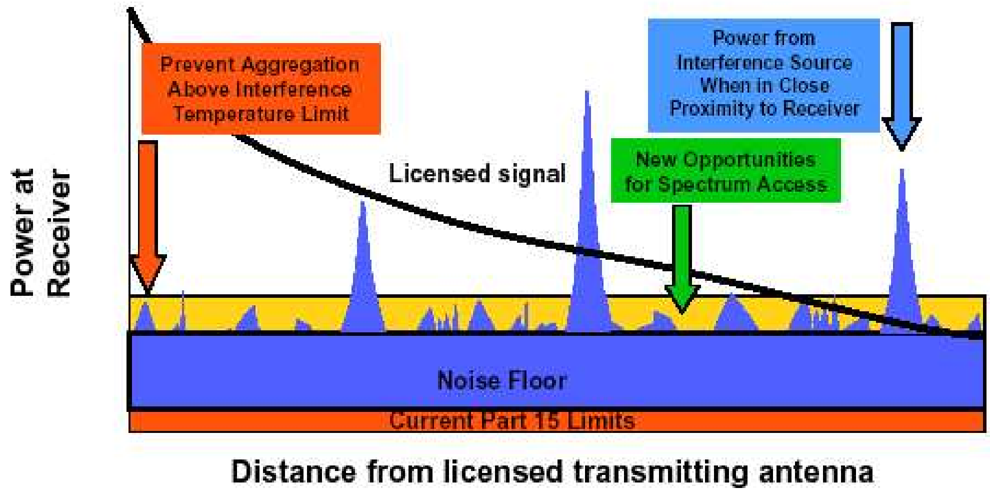

Figure 2

Figure 6 Reproduction of Motorola Report Figure 2

Even with the corrections from Motorola, there is still a significant fundamental problem with the original Figures in the Task Force Report and the modified Figures presented by Motorola. While all of the Figures represent current Part 15 emissions as being below the noise floor (perhaps well below the noise floor as indicated in the Figures), this is incorrect and it misrepresents the regulations contained in Part 15. For example, the current Part 15 limit for emissions above 960 MHz is 500 microvolts per meter at a distance of 3 meters from the transmitter (EIRP = -41.3 dBm/MHz) and is well above the thermal noise floor of any conventional receiver. In this case, the figure should be drawn as shown in Figure 7 (below).

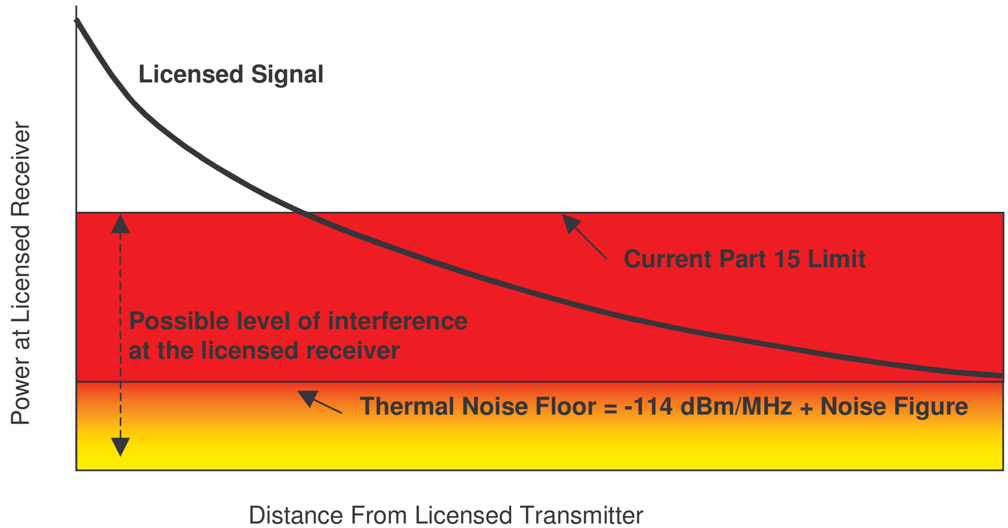

Figure 7 Incident power due to a licensed transmitter and a Part 15 transmitter.

As depicted in Figure 7 (above), current Part 15 EIRP limits are as high as -41.3 dBm/MHz, and the possible level of interference at the licensed receiver will vary according to frequency bands and other parameters. Depending on the locations of the two transmitters, it is possible that the signal from the Part 15 transmitter (or transmitters) would be significantly stronger than that of the licensed transmitter. Of course, it is also possible that the licensed signal would be stronger than the Part 15 transmitter. Without defining the relative positions, it is impossible to predict which signal would be the stronger as well as if the licensed service is able to achieve its required C/I as was described by Motorola. Thus, it is unclear how the Commission could define an "interference temperature" that would be generally applicable in real world situations.

It should also be noted that the thermal noise floor shown in the Figure 7 is assumed to be that in a reference bandwidth of 1 MHz. In this case, the thermal noise is equal to –114 dBm/MHz plus the noise figure of the receiver itself. For each individual receiver, the noise floor will depend on the equivalent noise bandwidth of the receiver and its noise figure.

Also, by adopting an artificially high level of system noise (i.e. the "interference temperature"), designers may have no incentive to continue to design high quality receivers exhibiting a low noise figure. In this case, it is possible that spectral efficiency may actually degrade over time rather than continue to increase. There is also an open question of how a transmitter will ever determine the noise figure of a potential victim receiver.

In addition, we strongly agree with Motorola's technical comments regarding interference avoidance, as stated within this proceeding:[33]

> "Adding interference and raising the noise floor at a minimum reduces coverage and in some cases totally disrupts communications."
>
> "Motorola stresses, however, that the concept of interference temperature proposed in the Task Force Report is fraught with difficulty."
>
> "One of the fundamental problems is that received power measurements at a single location do not indicate accurately whether a spectrum hole exists that can be exploited without harmful interference to primary users."
>
> "The determination or prediction of the level of interference that a non-primary user's transmissions will cause at another location is an immensely difficult problem."

Motorola continues, as V-COMM has also stated above, that "monitoring receivers may have different technical characteristics than the primary user's receivers." These differences contribute to the difficult task of identifying and exploiting the use of spectrum holes, and estimating the impact on the primary user. As described in the proceeding sections, these

[33] Motorola's comments submitted on Jan. 27, 2003, pages 13-14, 27, and Appendix A.

include the location of the sensors, the propagation loss differences, antennas & receiver characteristics, technology & transmission format, duty cycle, and other factors.

Reply Comments To Lucent's Statements

We strongly agree with Lucent's technical statements regarding CDMA system capacity and coverage degradations resulting from external interference. Their technical analysis and detailed comments substantially quantify the impact of external interference, in this respect. As Lucent stated:[34]

> "That is, the acceptance of a noise cap or interference temperature above the noise floor necessarily subjects the licensed, victim wireless system to increased external interference in the form of additional noise and can result in reduced signal to noise ratios, and, consequently, reduced call quality."

> "Specifically, CDMA technology, which will comprise a large part of 3G infrastructure, offers protection from internally generated system noise, but is susceptible to degradation caused by noise from external sources."

Reply Comments To Shared Spectrum Company's Statements

Shared Spectrum Company is actively pursuing the development of a system to support the Task Force concept of the "interference temperature". It should be noted that Shared Spectrum is one of the recipients of contracts from DARPA to work on the XG (NeXt Generation) program, which is exploring real-time, adaptive, spectrum sharing. The five year (or more) XG program only has been started recently and it must be assumed that any results to date are therefore preliminary. It is not surprising, however, that Shared Spectrum is already

[34] Lucent's comments submitted on Jan. 27, 2003, within the Interference Avoidance section.

advocating “near-term testing and early type acceptance of wireless systems that use the Interference Temperature concept for spectrum access.”[35]

According to their comments, Shared Spectrum believes that it has a workable method to design a system based on interference avoidance. Furthermore, it believes that “It is not necessary to defer setting different threshold levels for each band, geographic region, or service, until a noise survey is complete.” Thus, Shared Spectrum disagrees with both the Spectrum Task Force Report and the advice of the FCC’s own Technological Advisory Council which have both urged the Commission to conduct measurements and additional analysis to better understand the levels of noise and interference in the environment.

As described by Shared Spectrum, their technique is a receive-only system that would allow a secondary user of spectrum “to access spectrum and to not degrade the performance of any Primary system by more than a set threshold.” However, the technique requires the Primary user’s system to be semi-duplex as well as prior knowledge of the transmitter power level. (From their description it is unclear what “semi-duplex” means, from their Figure 1 it appears that the Primary system is full duplex but it may be that semi-duplex is intended to mean that Primary nodes are not transmitting at the same time on the same frequency.) As described, the nodes of the Secondary Network do not require location, or other, geographic information.

There are problems with this approach. If the locations of the Primary and Secondary nodes are not known, it is unclear how any knowledge of the transmit power of the Primary nodes will help the Secondary node to infer anything about the propagation loss. How will such a Secondary node know which transmitters it happens to be near and the respective transmit power? Additionally, it appears that the antenna patterns of the Primary and Secondary nodes

[35] Shared Spectrum submitted comments, Jan. 27, 2003.

are not taken into account, nor any shadowing or fading effects, nor any effects due to polarization differences of the Primary and Secondary user's antennas, nor any differences in system bandwidth, etc. Although it is claimed that antenna directionality and gain could be included, it is not clear how this would be included if the directions from the Secondary node to the Primary nodes are unknown. Also, the antenna effects must be included for both the Primary and Secondary node antennas. While Shared Spectrum claims that the system will be able to track fast fading and other multipath propagation effects there is not sufficient detail to determine this. It is also unclear whether the requirement of "semi-duplex" refers to systems operating in a time division duplexing (TDD) scheme as well as how this method would or would not work for systems employing frequency division duplexing (FDD). In particular for FDD systems, a Secondary node's receiver may only hear a signal from one of the two Primary nodes that are communicating and when the Secondary node is allowed to transmit it would severely impact the Primary node that is receiving.

Shared Spectrum claims their method also mitigates the "hidden terminal" problem that has been described by many in the comments to the Commission. However, it seems that there are potentially many instances, such as that given above for FDD systems, where this may not be true. Furthermore, it is not clear how the Secondary node receiver would know which frequency band to find each uplink/downlink frequency in question. Even with the improvements and refinements suggested in their comments, there are no details presented that describe how such a system will actually work. Even with such advanced technology, Shared Spectrum states that a "short-term loss of service to the Primary user" is possible but that this loss of service should be less than that caused by other factors "such as thermal noise fluctuations, man-made noise bursts, equipment faults, software faults, traffic overload, and others." This method of evaluating interference into the Primary user's system is completely unreasonable and should not be the basis for future spectrum regulation.

In addition to relying on the interference temperature concept, Shared Spectrum advocates the use of statistical methods that allow for greater power levels to be transmitted by Secondary nodes but these transmissions must be limited in both duration and number of occurrences. It seems impossible, however, that these types of limits could ever be enforced or maintained. Consider the scenario of several independent secondary nodes in an area: if each node was allowed to transmit multiple times per hour, or per minute, on each channel, the channel could easily become unusable by the Primary nodes. In the case of technologies that reuse their own frequencies, such as CDMA, this type of intentional interference would severely impact the entire system.

Even while Shared Spectrum is arguing for the near-term development of interference limits, it states that current Primary users "will correctly argue" for interference thresholds very close to the existing thermal noise floor. In this case, Shared Spectrum is correct in that existing licensees should be allowed to operate with their existing noise floor. As Cingular, Lucent and others have commented, additional sources of external interference should not be allowed in licensed bands, as these licensed services will suffer degradation.

III. DEFINITION OF HARMFUL INTERFERENCE

First and foremost, the definition of harmful interference must be addressed prior to the FCC's consideration of reforming spectrum policy and introducing new spectrum-sharing services within existing licensed spectrum. Without a clear understanding of the level of interference that constitutes harmful interference, licensed service providers, the Commission, and the public will be at a disadvantage. They will not have enough information to assess and interpret external system interference, to properly setup and perform system test measurements to confirm the existence of harmful interference, or to coordinate with others to resolve external system interference disputes.

The current FCC definition of harmful interference is subject to broad interpretation, is not quantifiable and is outdated. The definition of harmful interference contained in section 1.907 of the FCC Rules is "interference that … seriously degrades, obstructs, or repeatedly interrupts a radio communications service". The interpretation of this definition is overly subjective and not clearly understood. With this definition the Task Force and FCC regulations do not provide clear answers to the following interference issues:

- What constitutes acceptable vs. unacceptable interference?
- What constitutes a "serious" degradation in service?
- How many "obstructions" or failed system access attempts is considered harmful?
- How many "interruptions" during calls, or dropped calls does a system have to endure before it is considered to be experiencing harmful interference?

These questions and others need to be answered for radio service providers to understand their rights and responsibilities, how to manage their networks, and understand the risks associated with making new investments and upgrades to their networks. In this respect, the definition of harmful interference needs to be quantifiable, objectively measurable with accepted industry practices and procedures, and clearly understood.

The definition of harmful interference needs to be more specific relative to protected services and more reflective of modern times. The current definition is too generalized. It needs to represent modern technologies and offer protection for modern radio communications services. For example, in relation to modern communications services provided in the CMRS spectrum today, the following services and system attributes should be protected from harmful interference:

CMRS Services Protected from Harmful Interference

Voice Services –

[These voice services include voice communications.]

- Coverage – loss in range of transmission or margin of signal
- Capacity – loss in the number of customers supported
- Quality of Service – a deterioration in service performance, including dropped calls, failed system access attempts, or voice quality degradation

Data Services –

[These data services include data transmissions, standard & enhanced messaging, video, VoIP, data terminal sessions, Virtual Private Networks, web browsing, e-mails, games, and other multimedia services.]

- Coverage – loss in range of transmission or margin of signal
- Capacity – loss in the number of connections supported
- Throughput – reduction of the bandwidth or speed of data transmissions
- Latency – increased delay (waiting time) of data session
- Quality of Service – increased errors (not correctable) in data transmissions

Location Services –

[These location services include locates for E911 emergency calls, and other location services provided by the CMRS carrier.]

- Coverage – loss of in range of transmissions or margin of signals, used to perform locate services
- Quality of Service – reduction in location determination or accuracy

It is essential that modern communication services receive sufficient protection from the effects of harmful interference. This will establish regulatory and market certainty going forward, knowing that additional services deployed beyond standard voice technologies will be protected. Taking this into account, the definition of harmful interference should consist of similar language:

> Any measurable deterioration in the operation or performance of services provided by a licensed carrier.

This new definition complies with the FCC Chairman's statement[36] that "The public has made their desire for interference-free spectrum-based services quite clear. The challenge now rests with us [FCC] to deliver." This definition (above) meets the intent for an interference-free operation of licensed services and for spectrum-sharing users to comply. Further in the statement, the chairman states that "when our devices are not on, we could care less about interference". Or, in other words, when spectrum is not being used, interference cannot occur. This is analogous to the common definition of the word "sound", which requires someone hearing the event; i.e. if a tree falls in the woods does it make a sound? In these strict definitions for sound and harmful interference the event would not occur, however this does take into account other important factors. In particular, with respect to the Task Force's time-sharing spectrum proposal, the Task Force did not outline practical methods that would ensure the spectrum was not in-use and would not be used in the future. In addition, fail-safe mechanisms and prevention of false positives are not addressed. It should be noted in the same examples above that interference *would* occur if the event occurred after a service provider deployed additional services and/or advanced wireless technologies to take advantage of signals that may be at lower received power levels.[37]

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[36] Press Statement of Chairman Michael K. Powell on Spectrum Policy Task Force, released Nov. 7, 2002.

[37] Examples of these technologies are CDMA (IS95), 3G, UMTS and other spread-spectrum services.

Based on the system attributes outlined above, examples of harmful interference to CMRS services are as follows. For system coverage, harmful interference is the loss in transmission range or margin of signal necessary to sustain a CMRS service. The direct effect of a spectrum-sharing system is an increase in the spectrum noise floor, which has the potential to reduce the margin of signal and detection of signal at the primary system's receivers. For system capacity, harmful interference is the loss in the system's ability to provide services to customers. For example, in CDMA systems, an increase in the effective noise floor would reduce the number of users that can utilize the spectrum for its communications. Since CDMA signals operate below the thermal noise floor,[38] they are particularly sensitive to increases in the noise floor, and any increase has a direct and immediate impact. For quality of service, harmful interference would be exhibited as dropped calls, blocked calls, or a reduction in the quality of voice, data or location services. For data services, harmful interference is a decrease in data throughput, reliability, or an increase in latency; these are the system attributes of data services. For location services, harmful interference is a decrease in location determination or accuracy. For network based location solutions, additional base stations are required to receive signals closer to the noise floor with lower signal margins to triangulate and determine location. For handset based solutions using assisted GPS technology, the mobiles will need to measure interference-free GPS and base station signals very close to the spectrum noise floors, in addition to using CMRS spectrum. Interference to these measurements would affect the accuracy of location services. In summary, increases in spectrum noise floors would have a direct impact to these services and system attributes, and must be defined as harmful interference.

[38] CDMA signals have the ability to operate below the thermal noise floor of its receivers due to the inherent processing gain of the system. This processing gain is used to provide capacity for the system,

In addition to accepting this definition, the Commission should conduct comprehensive spectrum noise floor studies with industry participants to better understand the environmental noise levels. In addition, future services and system attributes should be evaluated for consideration on an ongoing basis along with the FCC's biennial review of its rules.

Along with a clear definition of harmful interference, the spectrum rights and responsibilities of all service providers need to be clearly defined. Technical system operating characteristics need to be addressed, including maximum out-of-band emissions; maximum in-band emissions; acceptable receiver performance; geographic service area; maximum service levels at boundary; exclusivity; flexibility; designated frequency range and bandwidth; maximum external system interference; and adjacent bands and geographic territories with compatible radio characteristics or the use of spectrum guard bands. As the Task Force states, there needs to be a clear and exhaustive definition of spectrum rights and responsibilities for licensed and unlicensed spectrum users.[39]

IV. SPECTRUM NOISE FLOOR STUDIES

As many others have commented[40] it is essential for the Commission to understand the current and evolving state of the radio environment before considering rule changes and adopting interference measurement procedures and tolerance levels. Also, the Commission should only rely on interference noise studies that are directly and recently measured by industry accepted procedures, verified by independent parties, and reproducible in subsequent field tests. It is

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and not as an interference margin for external systems, as deployed in military applications. In CMRS CDMA systems, there is no margin set aside for external interference.

[39] Report, Pg. 18.

[40] These comments submitted include Motorola, Cingular and Sprint on Jan. 27, 2003, in this proceeding.

imperative that spectrum noise studies be conducted using standard tests with actual market conditions, and appropriate test equipment and procedures for accurate results to be ascertained. Studies conducted many years in the past should also not be solely relied upon, as the state of radio environments may change with time. The Task Force and the Commission's Technical Advisory Counsel (TAC) also recommend "the Commission undertake a systematic study of the RF noise floor,"[41] in each RF band.

A. Comprehensive Spectrum Noise Floor Studies Conducted & Planned

V-COMM has conducted extensive and comprehensive spectrum noise floor studies in the CMRS spectrum bands. V-COMM is also planning and coordinating further spectrum noise floor studies to be accomplished in the 1st and 2nd quarter of 2003. Extensive documentation of the test results, test procedures, and technical comments concerning interpreting the data will be submitted into the Commission's record for the Commission's consideration and understanding of the radio environment in the CMRS spectrum bands.

V-COMM conducted comprehensive spectrum noise floor studies in the Cellular spectrum band, in diverse market conditions, with the actual radio environment present at standard CMRS base station equipment. These measurements were conducted on a collection of base stations across dense urban, urban, suburban and rural market environments, and over a 24 hour period. These measurements document actual CMRS provider receiver operating noise floors & radio environments.

The Cellular spectrum band noise floor studies' results show very low operating noise floor conditions. Interference levels were measured from –127 dBm to –119 dBm, with the

[41] Report, Pg. 5.

highest levels for dense urban market base stations, and an overall operating noise floor average of –126 dBm. With these low operating noise floor conditions, CMRS equipment serves cellular phone calls to very low levels, with a sufficient margin above this amount for quality service. This study did not include the lowest noise floor base station equipment or radio environments. For example, equipment with tower-top low noise amplifiers, super-conducting filter systems, or Quiet Rural market types were not included. In the future, these more sensitive radio conditions must be evaluated and considered as well.

These Cellular spectrum noise floor levels are consistent with observations V-COMM has made over the past several years in Cellular spectrum environments. These changes (lowering) in the Cellular spectrum operating noise floor can be attributed to a number of factors that have changed over time. Most significantly, these factors include: cellular mobile phones operating at significantly lower power than in earlier years of spectrum use; cellular mobile phones utilization within buildings; improvements in standard cellular base station equipment technology and performance specifications, and other changes attributed to the maturity of cellular market systems.

To increase and improve the use of spectrum, CMRS operators must continue this trend and lower their operating noise floors to meet the growing demand for voice and data services. This is particularly true for high-speed data services, which requires substantially more margins over the interference noise floor than voice services. For network-based E911 location services, these CMRS systems will also be required to utilize signals that are much closer to the noise floor, and at multiple base stations for accurate location triangulation and determination. These CMRS systems must not see an increase in their operating noise floors, or else new service deployments will be impeded.

V-COMM is also completing plans, procedures and coordination of additional spectrum noise floor studies in Personal Communication Service (PCS) spectrum. The results from these PCS spectrum tests and the Cellular spectrum noise floor studies will be fully documented and submitted to the Commission, within 90 days of this report. V-COMM recommends that the Commission should evaluate and consider the spectrum noise floor studies performed in accordance with licensed equipment operators and by industry engineers with experience in CMRS technology. These are the experts in their respective areas that have extensive industry knowledge of CMRS radio equipment, technology, radio environment.

V. SECONDARY MARKET ARRANGEMENTS

The secondary market proposal (spectrum leasing) is one of the few applications that holds promise in meeting the FCC Chairman's goal of increasing use of spectrum and the Task Force's mission of attaining "greater regulatory certainty, while minimizing regulatory intervention." Other spectrum-sharing alternatives will require substantially more intervention from the Commission to address, outline, enforce, and resolve ongoing interference issues with existing and future service providers. These tasks should not be underestimated and can be expected to be quite extensive.

In this arrangement the licensed operator maintains control over the new service and manages the integration of the new systems, along with addressing the compatibility and proper interference controls between both systems. In this respect, this concept differs substantially from other spectrum-sharing proposals. In this case, the spectrum-sharing interference issues are the responsibility of the licensed operator, which meets the goals of reduced regulatory intervention and increased use of spectrum without causing harmful interference to incumbent radio services.

V-COMM strongly agrees with statements made by Motorola in this proceeding:[42]

> "Motorola believes that secondary market arrangements would provide the most appropriate means of providing secondary users some access to exclusive use spectrum."
>
> "Under a secondary market approach, incumbent licensees would be able to determine the conditions under which secondary users would have access to their spectrum. This ability to manage spectrum access would ensure the prevention of harmful interference to incumbent operations. Easements, in contrast, would not allow incumbents any ability to control the parameters of the secondary use and thus raise the potential for unintended harmful interference."

Two examples of successful secondary market applications in the CMRS industry are provided below. Both applications resulted in an increased use of spectrum with the licensed operator maintaining and ensuring no harmful interference occurs.

The first example is Verizon Wireless's experience with Aeris.[43] Aeris approached Verizon Wireless' predecessor companies with a proposal to use the analog control channel to transmit small amounts of data. The applications include vending machine monitoring, alarm systems, pipeline monitors, electric meter reading and vehicle tracking. Aeris proposed to use the dialed digits field in an analog setup message and to interconnect with the roaming backbone network to access the data. The carriers recognized that the analog setup channel would be lightly loaded as cellular subscribers shifted to digital service, but that the setup channel would remain as long as there were still some analog users. So the Carriers implemented the Aeris proposal. Aeris markets the service independently from the Carriers. It reuses spectrum that was to become lightly loaded and the transmissions are under the command and control of the

[42] Motorola submitted comments, Jan. 27, 2003, Pg. 26.

cellular networks. Aeris was able to deploy nearly national coverage by utilizing the existing cellular backbone network used to coordinate roaming. This is an example of the activity that is possible under the current FCC rules. With additional flexibility, additional compatible services could be deployed, with the cellular operator maintaining full control over the new system.

A second example is cellular carrier's experience with Cellemetry.[44] Its service applications are similar to Aeris. It also shares the cellular network's analog spectrum and its backbone network to deliver a new data service, which is marketed by another company. In Cellemetry systems, the radios appear as roaming cellular phones and communicate to a centralized gateway. In this system, the Electronic Serial Number (ESN) field within an IS41 message acts as the 32 bit Cellemetry message, and its gateway and SS7 network adds timestamp & location information to the message. Cellemetry service requires no equipment modifications to the cellular infrastructure, only requiring updates to translation table entries.

Secondary market arrangements hold great promise in meeting the FCC Chairman's goal of increasing the use of spectrum and the Task Force's goal of providing "greater regulatory certainty, while minimizing regulatory intervention." This application leaves the responsibility of interference management with the licensed spectrum operator, who is better able to integrate the new service. Also, it allows the carrier to meet market demand while ensuring the integrity of existing and future services.

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[43] For more information refer to www.aeris.net.

[44] For more information refer to www.nmrx.com/h_cellemetry.asp.

VI. CONCLUSION

For the foregoing reasons, V-COMM respectfully requests the Commission to take consideration of the comments addressed in this report, to conduct a comprehensive and systematic study the radio spectrum environment, and to avoid adoption of the Task Force's interference temperature proposal. The Commission should carefully consider the effects that new spectrum-sharing services will have on increasing spectrum noise floors and deteriorating existing communications services. The Commission's objective to increase and improve use of radio spectrum should be carefully tempered against its primary goal of providing interference-free communication services.

Respectfully Submitted,

V-COMM, L.L.C.

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February 28, 2003

APPENDIX A – COMPANY INFORMATION & BIOGRAPHIES

V-COMM is a leading provider of quality engineering and engineering related services to the worldwide wireless telecommunications industry. V-COMM's staff of engineers are experienced in Cellular, Personal Communications Services (PCS), Enhanced Specialized Mobile Radio (ESMR), Paging, Wireless Data, Microwave, Signaling System 7, and Local Exchange Switching Networks. We have provided our expertise to wireless operators in engineering, system design, implementation, performance, optimization, and evaluation of new wireless technologies. Further, V-COMM was selected by the FCC & Department of Justice to provide expert analysis and testimony in the Nextwave and Pocket Communications Bankruptcy cases. V-COMM has offices in Blue Bell, PA and Cranbury, NJ and provides services to both domestic and international markets. For additional information, please visit V-COMM's web site at www.vcomm-eng.com.

BIOGRAPHIES OF KEY INDIVIDUALS

Dominic C. Villecco
President and Founder
V-COMM, L.L.C.

Dominic Villecco, President and founder of V-COMM, is a pioneer in wireless telecommunications engineering, with 22 years of executive-level experience and various engineering management positions. Under his leadership, V-COMM has grown from a start-up venture in 1996 to a highly respected full-service consulting telecommunications engineering firm.

In managing V-COMM's growth, Mr. Villecco has overseen expansion of the company's portfolio of consulting services, which today include a full range of RF & Network design, engineering & support; network design tools; measurement hardware; and software services; as well as time-critical engineering-related services such as business planning, zoning hearing expert witness testimony, regulatory advisory assistance, and project management.

Before forming V-COMM, Mr. Villecco spent 10 years with Comcast Corporation, where he held management positions of increasing responsibility, his last being Vice President of Wireless Engineering for Comcast International Holdings, Inc. Focusing on the international marketplace, Mr. Villecco helped develop various technical and business requirements for directing Comcast's worldwide wireless venture utilizing current and emerging technologies (GSM, PCN, ESMR, paging, etc.).

Previously he was Vice President of Engineering and Operations for Comcast Cellular Communications, Inc. His responsibilities included overall system design, construction and operation, capital budget preparation and execution, interconnection negotiations, vendor contract negotiations, major account interface, new product implementation, and cellular market acquisition. Following Comcast's acquisition of Metrophone, Mr. Villecco successfully merged the two technical departments and managed the combined department of 140 engineers and support personnel.

Mr. Villecco served as Director of Engineering for American Cellular Network Corporation (AMCELL), where he managed all system implementation and engineering design issues. He was responsible for activating the first cellular system in the world utilizing proprietary automatic call delivery software between independent carriers in Wilmington, Delaware. He also had responsibility for filing all FCC and FAA applications for AMCELL before it was acquired by Comcast.

Prior to joining AMCELL, Mr. Villecco worked as a staff engineer at Sherman and Beverage (S&B), a broadcast consulting firm. He designed FM radio station broadcasting systems and studio-transmitter link systems, performed AM field studies and interface analysis and TV interference analysis, and helped build a sophisticated six-tower arrangement for a AM antenna phasing system. He also designed and wrote software to perform FM radio station allocations pursuant to FCC Rules Part 73.

Mr. Villecco started his career in telecommunications engineering as a wireless engineering consultant at Jubon Engineering, where he was responsible for the design of cellular systems, both domestic and international, radio paging systems, microwave radio systems, two-way radio systems, microwave multipoint distribution systems, and simulcast radio link systems, including the drafting of all FCC and FAA applications for these systems.

Mr. Villecco has a BSEE from Drexel University, in Philadelphia, and is an active member of IEEE. Mr. Villecco also serves as an active member of the Advisory Council to the Drexel University Electrical and Computer Engineering (ECE) Department.

Relevant Expert Witness Testimony Experience:

Over the past five years, Mr. Villecco had been previously qualified and provided expert witness testimony in the states of New Jersey, Pennsylvania, Delaware and Michigan. Mr. Villecco has also provided expert witness testimony in the following cases:

- United States Bankruptcy Court

- Nextwave Personal Communications, Inc. vs. Federal Communications Commission (FCC) **

- Pocket Communications, Inc. vs. Federal Communications Commission (FCC) **

** In these cases, Mr. Villecco was retained by the FCC and the Department of Justice as a technical expert on their behalf, pertaining to matters of wireless network design, optimization and operation.

David K. Stern
Vice President and Co-Founder
V-COMM, L.L.C.

David Stern, Vice President and co-founder of V-COMM, has over 20 years of hands-on operational and business experience in telecommunications engineering. He began his career with Motorola, where he developed an in-depth knowledge of wireless engineering and all the latest technologies such as CDMA, TDMA, and GSM, as well as AMPS and Nextel's iDEN.

While at V-COMM, Mr. Stern oversaw the design and implementation of several major Wireless markets in the Northeast United States, including Omnipoint - New York, Verizon Wireless, Unitel Cellular, Alabama Wireless, PCS One and Conestoga Wireless. In his position as Vice President, he has testified at a number of Zoning and Planning Boards in Pennsylvania, New Jersey and Michigan.

Prior to joining V-COMM, Mr. Stern spent seven years with Comcast Cellular Communications, Inc., where he held several engineering management positions. As Director of Strategic Projects, he was responsible for all technical aspects of Comcast's wireless data business, including implementation of the CDPD Cellular Packet Data network. He also was responsible for bringing into commercial service the Cellular Data Gateway, a circuit switched data solution.

Also, Mr. Stern was the Director of Wireless System Engineering, charged with evaluating new digital technologies, including TDMA and CDMA, for possible adoption. He represented Comcast on several industry committees pertaining to CDMA digital cellular technology and served on the Technology Committee of a wireless company on behalf of Comcast. He helped to direct Comcast's participation in the A- and B-block PCS auctions and won high praise for his recommendations regarding the company's technology deployment in the PCS markets.

At the beginning of his tenure with Comcast, Mr. Stern was Director of Engineering at Comcast, managing a staff of 40 technical personnel. He had overall responsibility for a network that included 250 cell sites, three MTSOs, four Motorola EMX-2500 switches, IS-41 connections, SS-7 interconnection to NACN, and a fiber optic and microwave "disaster-resistant" interconnect network.

Mr. Stern began his career at Motorola as a Cellular Systems Engineer, where he developed his skills in RF engineering, frequency planning, and site acquisition activities. His promotion to Program Manager-Northeast for the rapidly growing New York, New Jersey, and Philadelphia markets gave him the responsibility for coordinating all activities and communications with Motorola's cellular infrastructure customers. He directed contract preparations, equipment orders and deliveries, project implementation schedules, and engineering support services.

Mr. Stern earned a BSEE from the University of Illinois, in Urbana, and is a member of IEEE.

Sean Haynberg
Director of RF Technologies
V-COMM, L.L.C.

Sean Haynberg, Director of RF Technologies at V-COMM, has over 13 years of experience in wireless engineering. Mr. Haynberg has extensive experience in wireless system design, implementation, testing and optimization for wireless systems utilizing CDMA, TDMA, GSM, AMPS and NAMPS wireless technologies. In his career, he has conducted numerous first office applications, compatibility & interference studies, and new technology evaluations to assess, develop and integrate new technologies that meet industry and FCC guidelines. His career began with Bell Atlantic NYNEX Mobile, where he developed an in-depth knowledge of wireless engineering.

While at V-COMM, Mr. Haynberg was responsible for the performance of RF engineering team supplying total RF services to a diverse client group. Projects varied from managing a team of RF Engineers to design and implement new a PCS wireless network in the NY MTA; to the wireless system design & expansion of international markets in Brazil and Bermuda; to system performance testing and optimization for numerous markets in the north and southeast; to the development and procurement of hardware and software engineering tools; to special technology evaluations, system compatibility and interference testing. He has also developed tools and procedures to assist carriers in meeting compliance with FCC rules & regulations for RF Safety, and other FCC regulatory issues. In addition, Mr. Haynberg was instrumental in providing leadership, technical analysis, engineering expertise, and management of a team of RF Engineers to deliver expert-level engineering analysis & reporting on behalf of the FCC & Department of Justice, in the Nextwave and Pocket Communications Bankruptcy proceedings.

Prior to joining V-COMM, Mr. Haynberg held various management and engineering positions at Bell Atlantic NYNEX Mobile (BANM). He was responsible for evaluating new technologies and providing support for the development, integration and implementation of first office applications (FOA), including CDMA, CDPD, and RF Fingerprinting Technology. Beyond this, Haynberg provided RF engineering guidelines and recommendations to the company's regional network operations, supported the deployment and integration of new wireless equipment and technologies, including indoor wireless PBX/office systems, phased/narrow-array smart antenna systems, interference and inter-modulation analysis and measurement, and cell site co-location and acceptance procedures. He was responsible for the procurement, development and support of engineering tools for RF, network and system performance engineers to enhance the system performance, network design and optimization of the regional cellular networks. He began his career as an RF Engineer responsible for the system design and expansion of over 100 cell sites for the cellular markets in New Jersey, Philadelphia, PA; Pittsburgh, PA; Washington, DC; and Baltimore, MD market areas.

Mr. Haynberg earned a Bachelor of Science degree in Electrical Engineering with high honors, and attended post-graduate work, at Rutgers University in Piscataway, New Jersey. While at Rutgers, Mr. Haynberg received numerous honors including membership in the National Engineering Honor Societies Tau Beta Pi and Eta Kappa Nu. In addition, Mr. Haynberg has qualified and provided expert witness testimony in the subject matter of RF engineering and the operation of wireless network systems for many municipalities in the state of New Jersey.